

PROCESS FOR THE EVALUATION OF SIGNALS IN AN SAR/MTI  
PULSED RADAR SYSTEM

The invention relates to a process for the evaluation (gating? translator) of the received signals in an SAR/MTI pulsed radar system according to the preamble of Claim 1.

By means of Synthetic Aperture Radar/Moving Target Indication (SAR/MTI) pulsed radar systems, SAR images can be taken, on the one hand, and, on the other hand, moving targets can be identified in the taken SAR images. Figure 1 shows the pulse sequence of a transmitted signal of an SAR/MTI pulsed radar system. Because of the different illumination times, which are required for achieving a high resolution in the case of the respective evaluation method, the pulse repetition frequencies of the transmitted SAR and MTI pulses deviate considerably from one another. For an SAR evaluation with a resolution of up to 1 m, an illumination time  $T_{\text{SAR}}$  of up to 30-60s is required. However, the illumination time  $T_{\text{MTI}}$  of a ground area for identifying and tracking moving targets normally amounts to 100-200 ms.

Figure 2 shows the received echo pulse sequence which essentially is a superimposition of SAR and MTI echo pulses. In the case of known SAR/MTI radar systems, the signal

evaluation takes place such that the taking and generating of SAR images and the analysis of the SAR images by means of MTI processes for identifying moving targets take place successively with respect to time. Normally, an SAR image is taken first which is subsequently examined in an MTI process with respect to moving targets.

A simultaneous analysis of the signals in an SAR and an MTI process can therefore only be carried out at great technical expenditures. For known processes for evaluating signals in SAR/MTI radar systems, the received signal is divided into two almost identical components, one part of the signal being fed to a device for the SAR signal evaluation and another part of the signal being fed to a device for the MTI signal evaluation. In this case, it is disadvantageous that the radar system, particularly the radar antenna, comprises a large number of constructional elements and technically requires high expenditures for its implementation. This results in additional disadvantages with respect to the considerable weight of the antenna. Another disadvantage is the large dimension of the antenna, which makes it difficult to integrate the antenna in a flying device.

It is therefore an object of the invention to provide a process which allows the processing of the received signals simultaneously with respect to the SAR and the MTI without requiring high technical expenditures. Another object is the

creation of an antenna for implementing the process.

These objects are achieved by means of a process according to Claim 1 and by means of the antenna according to Claim 5. Advantageous embodiments of the invention are the object of subclaims.

According to the invention, in the received echo pulse sequence of the received signal, each pulse, corresponding to an integral multiple of an integral ratio of the pulse repetition frequency  $PRF_{MTI}$  of the transmitted MTI signal to the pulse repetition frequency  $PRF_{SAR}$  of the transmitted SAR signal and received after a transmitted SAR pulse, is evaluated in an SAR process, and, according to the invention, the remaining pulses of the received echo pulse sequence of the received signal are evaluated in an MTI process, in which case the pulse for the MTI signal processing absent as a result of the SAR signal processing is reproduced by means of interpolation methods.

The invention as well as advantages of the invention will be explained in detail in the following by means of drawings.

Figure 1 is a representation of an example of a transmitted pulse sequence of an SAR/MTI radar system with transmitted SAR and MTI pulses;

Figure 2 is a representation of an example of an echo pulse sequence of an SAR/MTI radar system with transmitted SAR and MTI pulses;

Figure 3 is a representation of a first example of a schematic block diagram of an antenna arrangement according to the invention;

Figure 4 is a representation of a second example of a schematic block diagram of an antenna arrangement according to the invention.

As described above, Figure 1 is a view of an example of a transmitted pulse sequence of an SAR/MTI radar system with transmitted SAR and MTI pulses. Because of the lower pulse repetition frequency of the transmitted SAR pulse with respect to a transmitted MTI pulse, the emission of an SAR pulse takes place only after each fifth MTI pulse, 5 being the ratio of the pulse repetition frequency  $PRF_{MTI}$  of the transmitted MTI signal to the pulse repetition frequency  $PRF_{SAR}$  of the transmitted SAR signal. In the time window between the transmitted pulses, the radar system is switched to reception.

As an example, the echo pulse sequence of a transmitted signal is illustrated in Figure 2. The illustration shows a superimposition of SAR and MTI echo pulses. The pulse received in the time interval marked by reference number 1 in

Figure 2 is evaluated by means of a known SAR process. According to the invention, the MTI pulse lost in the process is reproduced by means of an interpolation process. Such an interpolation process is known, for example, from Joseph Salzmann et al., "Interrupted Synthetic Aperture Radar (SAR)"; IEEE AESS Systems Magazine, May 2002, Pages 33-39.

Advantageously, the ratio of the pulse repetition frequency  $PRF_{MTI}$  of the transmitted MTI signal to the pulse repetition frequency  $PRF_{SAR}$  of the transmitted SAR signal can be changed from one MTI burst to the next MTI burst. The distance ambiguities occurring during the MTI signal evaluation can be determined in this manner.

The pulse repetition frequency  $PRF_{SAR}$  of the transmitted signal advantageously amounts to between 200 Hz and 400 Hz, and the pulse repetition frequency  $PRF_{MTI}$  advantageously amounts to between 2 kHz and 4 kHz. Thus, integral ratios of the pulse repetition frequency  $PRF_{MTI}$  of the transmitted MTI signal to the pulse repetition frequency  $PRF_{SAR}$  of the transmitted SAR signal of 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 are conceivable. Naturally, it is also conceivable to set larger ratios by a suitable adaptation of the pulse repetition frequencies  $PRF_{SAR}$  and  $PRF_{MTI}$ .

Figure 3 is a schematic block diagram of a first special embodiment of an antenna arrangement according to the

invention.

The antenna arrangement 2 comprises a plurality of transmitting and receiving modules 3 (T/R modules). These T/R modules 3 are combined to a definable number of subgroups 3a.

The T/R modules 3 are applied to each subgroup 3a of a common delay link 4. A definable number of delay links 4 are advantageously combined and applied to a common digital receiving unit 5.

The digital receiving units 5 are advantageously connected with devices 6 for the digital beam shaping and for the moving target indication according to the STAP process (space time adaptive processing). The devices 6 for the digital beam shaping and for the moving target indication are advantageously applied to additional devices 6a for the SAR and MTI signal evaluation.

Figure 4 is a schematic view of a second special embodiment of an antenna. The antenna arrangement 2 comprises a plurality of T/R modules 3 which are combined to a definable number of subgroups 3a. In this embodiment, a definable number of delay links 4 are combined to an analog network 7 with a definable number of outputs 8 which are each applied to a digital receiving unit 5, particularly an analog-to-digital converter, the digital receiving units 5 each being applied by

means of devices 9 for the SAR and MTI signal evaluation. In this case, the analog network 7 simultaneously generates different narrow-band radiation patterns in different directions.